

*Library of the Royal College  
of Surgeons  
Presented by the author.*  
REPORT ON THE COAL GAS

SUPPLIED TO THE CITY OF LONDON;

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WITH EXAMPLES OF THE INJURY DONE TO BOOKS, &c., BY  
THE PRODUCTS OF ITS COMBUSTION,

BY

HENRY LETHEBY, M.B.

PROFESSOR OF CHEMISTRY AND TOXICOLOGY IN THE LONDON HOSPITAL,

ADDRESSED TO

THE COMMISSIONERS OF SEWERS

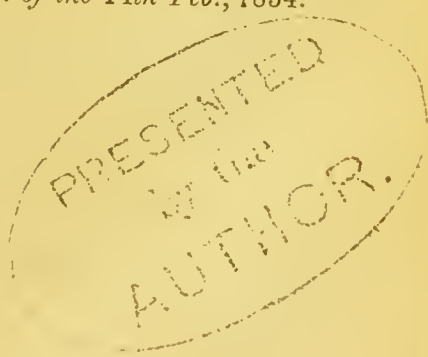
OF THE

CITY OF LONDON,



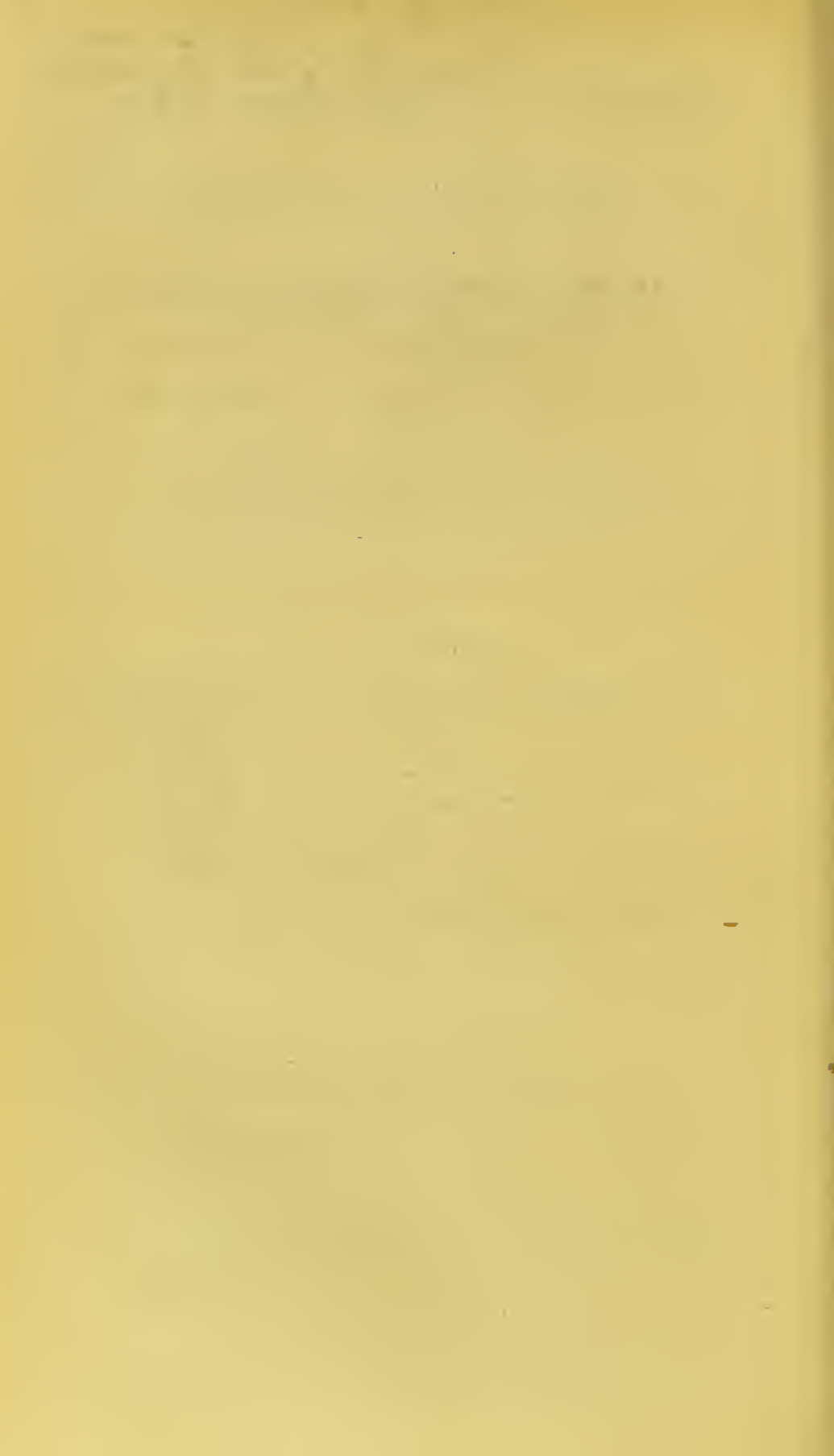
*Pursuant to Resolution of the Commission of the 14th Feb., 1854.*

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MAY 9TH, 1854.  
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C. DAWSON, PRINTER, 148 $\frac{1}{2}$ , FENCHURCH STREET, CITY.

1854.



*At a Meeting of the Commissioners of Sewers  
of the City of London, held at the Guild-  
hall of the said City, on Tuesday, May  
9th, 1854:—*

DR. LETHEBY attended and laid before the Court  
the following Report.

ORDERED—

That the same be printed, and a copy be sent to  
every member of this Court.

JOSEPH DAW,  
*Principal Clerk.*



# REPORT ON COAL GAS,

BY

HENRY LETHBY, M.B.

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TO THE HONORABLE THE COMMISSIONERS OF SEWERS  
OF THE CITY OF LONDON.

GENTLEMEN,

In accordance with a request made to me, through Mr. Daw, in the month of February last, I have made an examination of the illuminating power and chemical quality of the Gas supplied to the City of London by the different Gas Companies of this metropolis: those Companies are the Great Central, which supplies the whole of the City; the Chartered, of Brick Lane and the Curtain Road, which distributes gas to that part of the City which is north of Leadenhall Street, Cornhill, and Cheap-

side; the City Company, which supplies the district south of those streets, as well as that part of the City which is west of the General Post Office; the Commercial Company, which furnishes gas to a few streets in the neighbourhood of Aldgate; and lastly, the City Company, which sends cannel gas to the Times Office and General Post Office. The following is my report thereon:—

1st. *As regards the Illuminating Power.*—This has been tested in the usual manner; namely, with an Argand burner of 15 holes and a 7-inch chimney, consuming 5 cubic feet an hour—except in the case of the City cannel gas, where it was found necessary to burn it at the rate of 4 cubic feet an hour; the candle was a sperm candle of six to the pound, burning at the rate of 134 grains per hour, but calculated into the standard value of 120 grains per hour, and thence into its value in wax—the basis of the calculation being, that 13.8 sperm of 120 grains' consumption are equal to 15.8 wax of the like standard value. The Photometer was, as usual, enclosed in a dark chamber, so as to exclude, as far as possible, all light but that emitted in a direct line from the illuminating agents. But notwithstanding this precaution, and others which I have been obliged to adopt, the results which I am about to mention are, except in the case of the Great Central and Chartered of Brick Lane, a little over their true value; and this has arisen from the diffi-

culties which I have had to contend with, in rooms not properly fitted up for such experiments, in excluding a certain amount of diffused and reflected light.

In the following table the Companies are arranged in the order of their value:—

The City Cannel Gas equal to 13.7 sperm, or 15.6 wax			
The City Gas . . . „	13.5	„	15.5 „
The Great Central . . „	13.0	„	14.9 „
The Chartered of Cur-			
tain Road . . . „	12.9	„	14.7 „
The Commercial . . „	12.5	„	14.4 „
The Chartered of			
Brick Lane . . . „	12.2	„	13.9 „

From this it will be seen that the illuminating power of the Great Central Gas has been about 24 per cent. greater than is required by the Act of Parliament.

Another point to which I have directed attention is the *pressure* at which gas is delivered to the public by the different Companies. This is of importance, because, when the pressure is low, the street lights, and even the lights of our houses, are insufficient for the purposes required. I do not think that gas ought ever to be delivered at less than an inch of water pressure; and the pressure

should be as uniform as possible. The following are the results obtained upon this point.

	Least Pressure observed.		Greatest ditto, ditto.		Average Pressure of the Quarter.
City Company . .	1.5 inches of water.		2.2 inches of water.		1.8 inches of water.
Great Central . .	1.0 „		1.8 „		1.3 „
Commercial . .	.8 „		1.1 „		.9 „
Chartered, Brick Lane . . . .	.6 „		1.2 „		.8 „
Chartered, Curtain Road . . . .	.4 „		1.0 „		.7 „
Cannel Gas, after passing through Leslie's Governor &c. . . . .	.2 „		.4 „		.3 „

From this it will be seen that the Chartered Company not only furnishes gas at a rather low pressure, but the variation between the extremes is so great, that the public must suffer inconvenience from it. Both of the preceding tables have been calculated from about 160 observations.

2nd. *In Respect of Purity.*—Ammonia and tarry matter have been present in the gas in every instance, although the proportions of these impurities have not been the same in each case. This will be manifest from what follows. And here I ought to state, that, although the results may not represent the exact proportions of ammonia contained in each



of the Companies' gas, yet, as they were all obtained in a similar manner, namely, by passing the gas through a stratum of flints moistened with dilute hydrochloric acid, then evaporating and distilling with potash to obtain the ammonia in a free state, they represent the relative proportions of this alkaline impurity.

The Great Central contained in 100 cubic feet	.5	grains of ammonia
Cannel Gas, after passing		
Leslie's Purifier . . . . .	„	.6 „
Ditto, before . . . . .	„	1.0 „
Commercial Gas . . . . .	„	.8 „
City . . . . .	„	.9 „
Chartered, Brick Lane . . . . .	„	1.8 „
Chartered, Curtain Road . . . . .	„	3.8 „

I place before you a specimen of the ammonia obtained in this manner, and I also exhibit specimens of the fetid tarry matter which that ammonia held in suspension in the gas.

In a former report I alluded to the mischief that results from the presence of these impurities in coal gas ; and I now submit to your notice examples of the injury done to copper and brass-fittings by the ammonia, and a specimen of the soil of this metropolis infected by the tar. It has been thought by some persons who are unacquainted with the action of poisons on the living system, that because tar

happens to have the power of checking putrefaction and fermentation, it cannot exert any injurious action on the living body; but it might, were it necessary, be easily shown that the two effects are perfectly distinct—the one being an action on dead matter, and the other on living; besides which, it is known to all Toxicologists, that the most powerful antiseptics are the most powerful poisons; in addition to which I may state, that my own experience and practice have taught me that the fœtid effluvium from soil impregnated with gas-tar is highly injurious to health. I have known cases where the strongest individuals have been seriously affected by it.

The other impurity contained in coal-gas is bi-sulphuret of carbon. This, in the act of burning, becomes converted into sulphurous acid, the acid of the burning match, and then by further oxydation it is transformed into sulphuric acid.

According to Mr. Lewis Thompson, bi-sulphuret of carbon is a constant ingredient of coal-gas, which, he says, “seldom contains less than a 1000th part of its bulk.” If this were true, as much as 2,977 grains, or nearly one-third of a pound of anhydrous sulphuric acid would be produced by the combustion of a 1000 cubic feet of the gas. My own experiments, however, have not furnished me with anything like so enormous a result; and although they are amply sufficient to illustrate the pernicious effects of such a powerfully corrosive agent, yet they

do not, on the average, give me much more than a 20th part of Mr. Thompson's frightful amount. In fact, the largest proportion of sulphuric acid that I have ever obtained from coal-gas has not reached higher than 212 grains per 1000 cubic feet; and taking the average of 46 experiments made during the last year on the gas furnished by two of the City companies, it amounted to just 142 grains per 1000; this, however, is quite sufficient to be the source of incalculable mischief.

The gas supplied to the City during the last quarter has, on an average of nearly 100 experiments, given the following results:—

Proportions of anhydrous sulphuric acid yielded  
by 100 cubic feet of each of the Companies'  
gas—

City Cannel, before passing Leslie's Purifier . . . . .	8.7 grains
City Cannel, after ditto . . . . .	8.7 „
Chartered Gas, Curtain Road . . . . .	11.8 „
Great Central . . . . .	12.4 „
City Company . . . . .	13.1 „
Chartered Gas, Brick Lane . . . . .	13.6 „
Commercial . . . . .	13.9 „

I have noticed that the proportion of sulphur contained in gas is liable to great variation, and that the amount of acid yielded by it ranges from 6

grains to 21, per 100 cubic feet ; this shows, that if there is not a means of preventing its presence altogether, a supposition that I do not for a moment entertain, there is at any rate a means of keeping it down to half its present amount.

I have already stated in a former Report, that most of the sulphuric acid thus generated escapes into the atmosphere in the form of oil of vitriol, the proportion of which, as compared with the amount of anhydrous acid originally produced, is about one-fourth part more. The truthfulness of this statement has been publicly denied ; and it has been asserted that the ammonia of the gas always neutralizes the corrosive power of the acid thus formed. A little attention to figures, however, will show that the proportion of ammonia contained in coal-gas is not half enough to saturate the amount of acid produced ; and even if this were so, ammonia is so unstable a compound that it cannot resist the decomposing power of the burning gas, and cannot therefore be present to neutralize the acid ; this fact is so well known to chemists, that it is hardly necessary to say a single word in proof of it. I have, however, during the last 12 months, made such experiments as convince me that the fact is well founded, and that the greater part of the sulphur contained in coal-gas escapes into the air, not as sulphate of ammonia, but as corrosive vitriolic acid ; this is proved by the illustrations on the table before you. In bottles Nos. 1 and 2, you will find concentrated

solutions of oil of vitriol; those solutions have been produced by the combustion of less than 500 feet of coal-gas. In one case the gas was burnt under a platinum rosette, and in the other it was burnt in exactly the same way as the public consume it. In both cases the results are the same, namely, water and vitriolic acid. To prove that these liquids are highly corrosive, and therefore destructive to property, I have submitted various tissues, as of leather, paper, linen, and cotton, to their action; and, as you will perceive, the tissues of those fabrics are completely rotted. I place before you examples of the effects produced by liquids derived in this manner from each of the Companies' gas. It may perhaps be said that these experiments do not fairly represent the actual condition of things when gas is burnt by the public; to this I reply, that I have done nothing to exaggerate the results; I have simply burnt the gas at the rate of half a cubic foot an hour from a Leslie's burner, and have collected the products in a clean glass vessel; but to do away with all objection upon this score, I have obtained from Mr. Spencer Hall, of the Athenæum Club House, a sample of the water actually produced by the combustion of the gas in the hall of that establishment, and condensed in the cistern of the ventilating pipe, which was designed by Professor Faraday some years ago. This water I also place before you; and you will notice that it is so charged with copper, that it has a deep-bluish



green colour. I find on analysis that it contains about an ounce and a quarter of sulphate of copper in the pint; this has been derived from the sulphuric acid of the gas and the copper of the ventilating tube. Indeed, the acid must have been in a free or corrosive state, or it would not have attacked the metal in the way in which it has. Mr. Spencer Hall has likewise given me a portion of the deposit found in the ventilating chamber of the library; and, here again, you will notice that the deposit is composed of sulphuric acid and copper. Two similar specimens have also been furnished to me by Mr. Faraday, of Wardour Street, and these I have placed on the table for your inspection. Again, I am informed by Mr. Thornhill, of the Literary and Philosophical Society of Newcastle-upon-Tyne, that in the library of that institution, where they have fitted up four ventilators over the chandeliers of the room, as much as half a gallon of water is collected of a night from the gas which is burnt there; this water is so corrosive from the presence of sulphuric acid, that it attacks all the metal fittings with which it comes into contact, and thereby acquires a metallic impregnation of copper and iron. I have analysed the various specimens of these liquids and deposits, but do not find that they contain more than a mere trace of ammonia. This demonstrates beyond all doubt that sulphuric acid is produced by the combustion of the gas, and that little or no ammonia escapes to neutralize it.

I proceed now to examine the question, as to the effects of this destructive compound on various articles of furniture, &c. The specimens of leather, paper, cotton, and linen now upon the table, will prove to you that the corrosive power of the acid is very considerable; in addition to these, I have obtained a few facts which are of public interest.

Through the kindness of the managers of the Athenæum Club House, I have had access to the various documents which they possess, on the subject of the injury done to the library of that Institution by the products of burnt gas; and I find that in the summer of 1842 a Committee was appointed to investigate this subject, and that the services of Professors Faraday and Brande, Mr. Aikin, Mr. Brown, and Dr. Prout were enlisted. Without going into the detail of their investigations, which went to show that oil of vitriol was the great cause of the mischief, I will inform you of the result at which they arrived. Dr. Prout said that he had taken two equal portions of the water used in the house, and had exposed one of these for a fortnight to the air of the drawing room of the establishment; by which means he found that it thereby acquired a striking increase of sulphuric acid, so that when it was evaporated nearly to dryness it distinctly reddened litmus paper, and showed the presence of free sulphuric acid. "This," said Dr. Prout, "sufficiently explains the destruction of the books, nor will there be any

improvement till the gas is either removed or its fumes conducted away by appropriate chimneys." Mr. Faraday and Mr. Aiken agreed in this opinion; and the Committee resolved that, as from the above experiment it appeared that much of the injury suffered by the books in the library is owing to acid vapours evolved by the combustion of the gas, it is advisable that, for the preservation of the library, the gas should either be discontinued, or that some arrangement be adopted for carrying off the fumes, by an improved system of ventilation. In the end the latter was adopted at the suggestion of Professor Faraday, and, although the mischief has been to a great extent abated, yet, I am informed by Sir Henry Ellis, that he thinks he sees a certain degree of injury still progressing. Through the kindness of Mr. Magrath, the Secretary of the Club, and Mr. Spencer Hall, the Librarian, I am enabled to show you numerous specimens of the covers of books which have been thus injured; and you will notice that wherever they have been exposed to the atmosphere containing the vapours of burnt gas, they are as rotten as tinder; indeed, it often happens that the covers give way in attempting to remove the book from its place on the shelf.

At the London Institution, in Moorfields, the books have suffered in a similar way; and Mr. Brayley the Librarian tells me that the books situated in the upper part of the room suffer most.



He noticed that the surface of the leather of the binding lost its smoothness, and eventually the whole was reduced to a brittle substance, composed of a scarcely coherent powder, which had a powerful acid taste; to this he adds, that evidence has been obtained from bookbinders, as well as booksellers, of the deleterious action of gas lights and gas stoves on the bindings of books. In consequence of this a ventilating apparatus has been put up in the library of the Institution.

Mr. Spencer Hall informs me that almost the entire library of the Earl of Tyrconnel, at Kilpin, in Yorkshire, whose mansion is lighted with gas, has been destroyed in a similar way; and Mr. Brayley confirms this fact. The latter gentleman has also told me that mischief of a like description has occurred in the Portico Library at Manchester; and, from a statement made in a leading article of the Times, of the 14th of January last, it appears that the books in one of the rooms of the Times Office, where gas is constantly burnt, shrivel up and break after two or three years exposure.

Within the last day or two I have visited the library of the Royal College of Surgeons, in Lincoln's Inn Fields; and although gas is not regularly burnt therein, yet it is surprising to see how much mischief has been done to the bindings of the books by the products of gas combustion. I should think, that in the gallery of that Institu-

tion there are hundreds, if not thousands of books, the backs of which are completely rotten; and Mr. Stone, the late librarian, tells me that he has the most satisfactory proof of its being due to the action of gas, in the circumstance, that whenever a book has been taken out of the library for any length of time it is found to be preserved, although its fellow volumes are thoroughly rotted. I place before you a few examples of the injury done to the books of that establishment.

Mr. Thornhill, the librarian of the Literary and Philosophical Society of Newcastle-upon-Tyne, has written to me to say that an enormous amount of mischief has been done to the books of that Institution, "It may," he says, "be stated generally that all the books which have been in the library for a few years have suffered more or less from exposure to the action of the matters thrown off from the gas, and that large sums have been expended in bookbinders bills, and will yet have to be expended before the mischief is repaired." The nature of the mischief, he says, is in the entire destruction of the texture of the leather, and even of the ends of the books; and, as might be expected, the books in the upper part of the room have suffered most. "In a room where books of reference such as Encyclopædias, Dictionaries, &c., are kept, and which is used also as a reading room, the quantity of gas burnt is large in proportion to the size of the room: in most cases the leather on

the backs of the books in this room has been frequently renewed, both in cases in which the books were frequently used, and in which they were not used at all; the backs in fact became loose as the books stood upon the shelves."

And now comes a very instructive observation which has been communicated to me by Mr. Thornhill. In the case of books missing from the library being recovered, the leather of the books so restored has been found perfectly good, whilst the leather on the books in the same binding has been utterly destroyed, although the books had been standing almost undisturbed (excepting for being dusted) on the shelves; one book was recovered after having been out of the library ever since the year 1818, it had in fact been replaced; it is bound in an inferior Russia which is perfectly sound and good. In a set of Dodsley's Annual Register, bound in the same leather, and purchased a few years ago in first rate condition, the leather could be easily brushed off by a hard brush."

It might be thought that the mischief here alluded to arises from other causes than the combustion of gas, but the proofs of its action are so clear, that it is not necessary to discuss this point; indeed, I have ascertained by actual analysis that the leather on the sides of the damaged books is uninjured, while that on the back is completely rotten: this is dependant on the circumstance that the atmosphere is excluded from the sides by reason of their pressure against

the neighbouring books, whilst the back is freely exposed to its influence.

Other tissues besides leather are acted on in the same manner. I have put on the table a specimen of gutta percha that has been completely destroyed by exposure to the heat and acids of gas as it lay in a shop window. Dr. Prout long since showed that all the furniture of the Athenæum Club House was damaged by the same agents; and it is not possible to examine a single fabric in London, without finding it charged with a greater or less proportion of sulphuric acid. Dr. Christison, of the University of Edinburgh—the well known author of our best English treatise on poisons—informs me, that the gas in Edinburgh kills all the plants in the rooms of that city. “Even a bouquet,” he says, “undergoes rapid withering, if shut up in a room for some hours, where gas is burning freely. I have observed this sometimes under my own nose in the summer, when, in the evening, the door of my room has been a little open.” In addition to this, he states that the curtains in the upper part of the rooms are apt to go, and that the silver of the jewellers’ shops is quickly tarnished by it.

It may now be asked whether I can suggest any remedy for the evil. I reply that the remedy is threefold:—1st. In respect of the manufacture of gas; 2nd. As regards its purification; and 3rdly. In a more perfect system of ventilation.



1st. At present, gas is manufactured from materials which are known to contain a large per centage of bi-sulphuret of iron; and the temperature at which the gas is made is far too high for sanitary purposes.

2nd. Although much attention has been directed to the purification of gas from one or two of its impurities, little or no notice has hitherto been taken of the most important of all, namely, bi-sulphuret of carbon.

3rd. It is advisable that gas should be burnt outside the room or shop whenever it is practicable; and when this is not the case, the products of the combustion should be conveyed away by a special contrivance as speedily as possible; indeed, they ought not to be allowed to escape into the room at all.

I am quite sure that many elegant arrangements may be suggested for this purpose, whenever the public are made aware of its importance.

I have the honor to remain,

Your obedient Servant,

(Signed) HY. LETHEBY, M.B.,

*Professor of Chemistry and Toxicology  
in the London Hospital.*

*London Hospital,*

*May 8th, 1854.*

